REMARKS

Applicants are amending their claims in order to further clarify the definition of various aspects of the present invention. Specifically, Applicants have amended claim 33 to recite that the acid dianhydride, reacted in forming the specified polyimide resin of the adhesive layer has been purified by recrystallization with acetic anhydride. Note, for example, the second full paragraph on page 17 of Applicants' specification.

The concurrently filed Request for Continued Examination (RCE) Transmittal is noted. In view of the filing thereof, it is respectfully submitted that the present amendments are to be entered as a matter of right, notwithstanding the Finality of the Office Action mailed August 3, 2010. Moreover, it is respectfully submitted that the present amendments and the following Remarks constitute the necessary Submission under 37 CFR 1.114 supporting this RCE Transmittal.

Applicants respectfully submit that all of the claims presented for consideration by the Examiner patentably distinguish over the teachings of the references applied by the Examiner in rejecting claims in the Office Action mailed August 3, 2010, that is, the teachings of the U.S. patent documents to Kikkawa, et al., Patent Application Publication No. 2002/0048726, to Nakaso, et al., Patent No. 5,690,837, and to Hotta, et al., Patent No. 5,904,505, Japanese Patent Document No. 2000-104040 (referred to by the Examiner as "Fujii"), and Japanese Patent Document No. 11-140386 (referred to by the Examiner as "Takashi"), under the provisions of 35 USC 103.

It is respectfully submitted that the teachings of the applied references would have neither disclosed nor would have suggested such an adhesive film as in the present claims, having the adhesive layer containing the polyimide resin (A) having

the SP value of 10.0-11.0 $(cal/cm^3)^{1/2}$, a weight-average molecular weight in the range of 10,000 to 200,000, and a Tg in the range of -20 to 60°C, with at least one of the polyimide resins of the polyimide resin (A) being obtained by reacting a diamine and an acid dianhydride satisfying the condition where a difference between a heat generation initiating temperature and a heat generation peak temperature by means of DSC is 10°C or smaller, the acid dianhydride having been purified by recrystallization with acetic anhydride, and wherein a tan δ peak temperature is -20 to 60°C, and a flow amount is 100-1,500 μm, both the tan δ peak temperature and flow amount being measured under specified conditions. See claim 33.

As will be discussed in more detail infra, it is emphasized that according to the present invention the acid dianhydride has been purified by recrystallization with acetic anhydride. In connection therewith, the contentions by the Examiner in Item 33 on page 10 of the Office Action mailed August 3, 2010, are noted. It is respectfully submitted that the acid dianhydride used in forming the polyimide resin has been purified by recrystallization with acetic anhydride, and consequently the acid dianhydride satisfies the condition where a difference between a heat generation initiating temperature and a heat generation peak temperature by means of DSC is 10°C or smaller. Thus, the purification of the acid dianhydride through recrystallization with acetic anhydride, is an important feature of the present invention. That is, it is important to purify an acid dianhydride by recrystallization with acetic anhydride; it is only when the acid dianhydride has been purified by recrystallization with acetic anhydride, that an acid dianhydride can satisfy the condition where a generation between a heat generation initiating temperature and a heat generation peak temperature by means of DSC is 10°C or smaller, as set forth in the present claims.

It is respectfully submitted that there are many methods to purify acid dianhydrides, and many conditions to purify acid dianhydrides. In addition, there are many methods for defining the purity degree of the acid dianhydride. According to the present invention, the degree of purity of the acid dianhydride is defined by the condition that a difference between a heat generation initiating temperature and a heat generation peak temperature by means of DSC is 10°C or smaller. It is respectfully submitted that none of the applied references would have disclosed, or would have suggested, either alone or in combination, purification of the acid dianhydride by recrystallization with acetic anhydride, and advantages achieved thereby. In particular, it is respectfully submitted that the combined teachings of the applied references do not disclose, nor would have suggested, use of such purified acid dianhydride, with such acid dianhydride satisfying the condition where a difference between a heat generation initiating temperature and a heat generation peak temperature by means of DSC is 10°C or smaller, and advantages achieved thereby, e.g., wherein both a suitable flowability and high efficacy of a curing reaction can be realized. Note the second full paragraph on page 17 of Applicants' specification.

As to the condition of a difference between a heat generation initiating temperature and heat generation peak temperature by means of DSC as in the present claims, attention is respectfully directed to the adhesive film of the Comparative Example 1, containing polyimide A'. As recognized by the Examiner in Item 33 on page 10 of the Office Action mailed August 3, 2010, the sole difference between Comparative Example 1, and, e.g., Example 2, is the polyimide resin, polyimide A used in Example 2 having been purified according to the present invention, while polyimide A' used in Comparative Example 1 has not been so

purified. Note polyimides A and A' on pages 62 and 63 of Applicants' specification; and see Table 2 on pages 73 and 74 thereof. That is, the only difference between Example 2 and Comparative Example 1 in the compositions is the acid dianhydride.

The adhesive film of Example 2 in the present application has a good flow amount.

In contrast, the polyimide resin of the Comparative Example 1, not utilizing the acid dianhydride purified as in the present claims, does not satisfy the condition where a difference between a heat generation initiating temperature and a heat generation peak temperature by means of DSC is 10°C or smaller. Specifically, a difference in Comparative Example 1 is 11.1°C. Moreover, a flow amount of the adhesive film of Comparative Example 1 is 2810 μm, not within the range of the present invention. Such flow amount as in Comparative Example 1 results in a deteriorated re-flowability resistance and deteriorated expansion resistance in the adhesive film of Comparative Example 1.

In contrast, Example 2, having a difference between a heat generation initiating temperature and a heat generation peak temperature by means of DSC of 10°C or smaller, has good flow properties.

According to the present invention, the advantages of the present invention are achieved not only through use of the acid dianhydride satisfying the condition where a difference between a heat generation initiating temperature and a heat generation peak temperature by means of DSC is 10°C or smaller, but also by the SP value of the polyimide resin, and the polyimide having the specified difference between heat generation initiating temperature and heat generation peak temperature being contained at 50% by weight or more of a total polyimide resin, among other properties as set forth in the present claims. These properties of the

polyimide resin affect compatibility with the epoxy resin and reactivity between the polyimide resin and epoxy resin, flow amount of the adhesive being affected by such compatibility and such reactivity. That is, according to the present invention, not only is the SP value and difference between heat generation initiating temperature and heat generation peak temperature properties important, but also other properties claimed in, e.g., claim 33 are important. Specifically, all of the properties of SP value of the polyimide, Tg, weight-average molecular weight, difference between a heat generation initiating temperature and heat generation peak temperature, such polyimide formed having such difference being contained at 50% by weight or more of a total polyimide resin, ratio of polyimide and epoxy resins, and flow of the adhesive, are important properties for achieving the advantages and objectives of the present invention, as can be seen in the evidence in the Examples in Applicants' specification. It is respectfully submitted that this evidence clearly supports a conclusion of non-obviousness, and overcomes any possible prima facie case of obviousness established by the teachings of the applied references.

As to this evidence in Applicants' specification, attention is especially respectfully directed to Comparative Example 1 seen in the continuation of Table 2 on page 74 of Applicants' specification, and the results in connection therewith shown in Table 3 on page 85 of Applicants' specification. The adhesive film of Comparative Example 1 includes a polyimide resin having an SP value, Tg and weight-average molecular weight within the scope of these properties in the present claims, and contains an epoxy resin in an amount as in the present claims. However, the polyimide resin in Comparative Example 1 was obtained by reacting a diamine and acid dianhydride which does not satisfy the condition where a difference between a heat generation initiating temperature and a heat generation peak

temperature by means of DSC is 10°C or smaller; specifically, the difference thereof is 11.1°C in Comparative Example 1. A flow amount of the adhesive film of Comparative Example 1 is 2810 μm, outside the scope set forth in the present claims. Such flow amount as in Comparative Example 1 results in a deteriorated re-flowability resistance and a deteriorated expansion resistance in the adhesive film of Comparative Example 1. It is respectfully submitted that this Comparative Example 1 shows importance of this feature of difference between heat generation initiating temperature and heat generation peak temperature, to achieve the advantages of the present invention. As mentioned previously, it is respectfully submitted that the teachings of the applied references would have neither disclosed nor would have suggested such feature of the present invention, especially in combination with the other properties set forth in the present claims, and advantages achieved thereby.

It is emphasized that an object of the present invention is to realize both low temperature laminating property and resistance to re-flowability. Such properties are affected by the flow amount of the adhesive, and the objects of the present invention, as found by Applicants, can be reached by using a specific polyimide resin, with specific properties such as SP value, Tg and weight-average molecular weight, by using a specific acid anhydride as raw material for the polyimide, having specific properties, and using an amount of epoxy resin and polyimide in a weight ratio as set forth in the present claims.

It is respectfully submitted that none of the applied references, either alone or in combination, would have taught or suggested the combination of features/properties for the adhesive and for the polyimide as in the present claims, or even some of the recited features/properties per se, or that such combination of

features/properties for the adhesive film provides an adhesive film achieving the objectives of the present invention, including low temperature laminating property and resistance to re-flowability.

In Items 10 and 11 on page 4 of the Office Action mailed August 3, 2010, the Examiner contends that as the polyimide resin of Fujii is formed by tetracarboxylic acid dianhydride and diamine, it is reasonable to presume that the properties of the present claims are necessarily present in the polyimide resin and adhesive of Fujii, as modified by Kikkawa. However, it is respectfully submitted that Comparative Example 1 specifically rebuts this conclusion by the Examiner. That is, Comparative Example 1 in Applicants' disclosure forms a polyimide by reaction between tetracarboxylic acid dianhydride and diamine, yet does not achieve properties as set forth in the present claims; and, in particular, the polyimide resin of Comparative Example 1 does not utilize an acid dianhydride having been purified by recrystallization with acetic anhydride, and does not have properties as in the present claims, including a difference between a heat generation initiating temperature and heat generation peak temperature.

Furthermore, it is respectfully submitted that the teachings of the applied references would have neither disclosed nor would have suggested such adhesive film as in the present claims, having features as discussed previously in connection with claim 33, and, moreover, wherein the epoxy resin contains a tri-or more functional epoxy resin and/or an epoxy resin which is solid at room temperature (note claim 2); and/or wherein the adhesive film also contains an epoxy resin curing agent (see claim 6, and claims dependent thereon), or a filler (see claim 15) and amount thereof (see claim 18).

The present invention as being considered on the merits in the above-identified application is directed to an adhesive film.

Previously, in connecting a semiconductor chip and a semiconductor chip-carrying support member, a silver paste has been mainly used. However, with recent miniaturizations, it has been necessary to find other materials for such connection.

In addition, through recent advances in miniaturization and thinning of semiconductor chips, wherein such chips and the wafer from which such chips are formed are very thin, the wafer is fragile and is easily cracked; and, in order to prevent cracking of the wafer, a procedure of applying, as a protecting tape, a polyolefin-based back grind tape to the surface of the wafer, has been adopted. However, since a softening temperature of the back grind tape is 100ºC or lower, it has been demanded that an adhesive film, which can be laminated on a back of a wafer at a temperature of 100ºC or lower, be provided. Note the sole full paragraph on page 3 of Applicants' specification. Furthermore, it is required that easy peelability be achieved between the adhesive film and a dicing tape, and it is desired that the adhesive film has a low temperature laminating property and resistance to re-flowability, so that a reliable package can be achieved.

Against this background, and in light of the desire to provide an adhesive film having both a low temperature laminating property and resistance to re-flowability, Applicants achieve these objectives by the adhesive film of the present invention, utilizing a polyimide resin having been formed using an acid dianhydride and having properties as set forth in the present claims, with amount of polyimide resin and epoxy resin in the adhesive film as in the present claims, and with the adhesive film

having properties including, inter alia, a tan δ peak temperature and flow amount as in the present claims.

In particular, by utilizing a polyimide having a Tg as in the present claims, the adhesive film has a desired laminating temperature, adverse effects on a back grind tape are avoided, and warpage of a semiconductor wafer is suppressed. Note, for example, the paragraph bridging pages 23 and 24 of Applicants' specification. By utilizing a polyimide having a weight average molecular weight as in the present claims, acceptable film-forming properties, and strength of the film, are achieved, while deterioration of flowability at heating and reduction of embedding properties in irregularities on a substrate, are avoided. Moreover, by using a polyimide with Tg and a weight average molecular weight of the polyimide as in the present claims, not only a laminating temperature can be reduced, but also a heating temperature (die bonding temperature) when a semiconductor chip is adhered and fixed to a semiconductor chip-carrying support member can be reduced, and an increase of warpage of a chip can be suppressed. Note the paragraph bridging pages 24 and 25 of Applicants' specification.

By utilizing a polyimide resin also having an SP value as in the present claims, a reduced intramolecular cohesive force is avoided, so that an increase in hot flowability of an adhesive film in B stage does not become unduly large, and a reduction in adherability of the adhesive film with a substrate is avoided, while an increase in water absorption of an adhesive film is avoided. Note the last full paragraph on page 25, as well as the paragraph bridging pages 25 and 26, of Applicants' specification.

It is noted that according to the present invention, a desired tan δ peak temperature is achieved while still including a polyimide resin of a desired SP value, as described in the last full paragraph on page 28 of Applicants' specification.

As to advantages of the present invention having a tan δ peak temperature and flow amount as in the present claims, note also the paragraph bridging pages 45-47 of Applicants' specification.

It is emphasized that objectives of the present invention are to realize both a low temperature laminating property and resistance to re-flowability, and that these objectives can be achieved according to the present invention using a specific polyimide resin with a specific combination of properties such as SP value, Tg (of -20 to 60ºC) and weight average molecular weight (of 10,000 to 200,00), by using a polyimide obtained by reacting a diamine and an acid dianhydride satisfying a condition of difference in heat generation initiating and peak temperatures as in claim 33, the acid dianhydride having been purified by recrystallization with acetic anhydride, and by using the epoxy resin in amounts relative to that of the polyimide resin as in claim 33.

The Tg of the polyimide resin is an important feature of the adhesive film of the present invention. With a Tg as in the present claims, the adhesive film is allowed to have a tan δ peak temperature of -20 to 60ºC, and to achieve a low temperature laminating property.

Fujii discloses a die bonding adhesive comprising a thermoplastic polyimide resin having a glass transition temperature of not higher than 90°C and a thermosetting resin. Note, for example, paragraph [0007] of this patent document, as well as the English language abstract thereof. See also paragraph [0013] of this patent document.

As stated by the Examiner in Item 6 on page 3 of the Office Action mailed August 3, 2010, Fujii is silent as to teaching the weight-average molecular weight of the polyimide. Moreover, it is respectfully submitted that Fujii is also deficient in teachings in connection with various other properties of the adhesive film as recited in the present claims, including, inter alia, SP value, tan δ peak temperature, flow amount and difference between heat generation initiating temperature and heat generation peak temperature of the diamine and acid dianhydride used in forming the polyimide resin, or use of the dianhydride having been purified as set forth in the present claims, or amount of such polyimide resin, of total polyimide resin, satisfying such difference condition, as in the present claims, and advantages thereof, as discussed in the foregoing.

It is respectfully submitted that the additional teachings of Kikkawa, et al. would not have rectified deficiencies of Fujii, such that the presently claimed invention as a whole would have been obvious to one of ordinary skill in the art.

Kikkawa, et al. discloses a polyimide precursor as described in paragraphs [0008] and [0009] of this patent document, soluble in an alkaline aqueous solution and which can be used in a photosensitive material suitable for surface coating films of semiconductor devices or interlaminar insulating films of thin-film multilayer circuit boards. Note paragraph [0015] on page 1 of this patent document; see also paragraphs [0018], [0023] and [0024] on page 2 of this patent document. As applied by the Examiner, note also paragraph [0139] on page 23 of this patent document, describing that the polyimide film of Example 29, when evaluated in the same manner as described in Example 28, exhibited high adhesive properties.

Even assuming, arguendo, that the teachings of Kikkawa, et al. were properly combinable with the teachings of Fujii, such combined teachings would have neither disclosed nor would have suggested the adhesive film as in the present claims, wherein the polyimide resin of the adhesive layer includes the polyimide resin formed using the acid dianhydride purified as in the present claims, or wherein the polyimide resin includes all properties as in the present claims, including the SP value, and includes at least one resin obtained by reacting a diamine and an acid dianhydride satisfying the condition of difference between heat generation initiating and heat generation peak temperatures as in the present claims, or tan δ peak temperature and flow amount as in the present claims, and advantages achieved thereby.

As to the properties referred to by the Examiner in Item 10 on page 4 of the Office Action mailed August 3, 2010; it is respectfully submitted that the Examiner has not established a proper basis for the presumptions set forth therein; to the contrary, it is respectfully submitted that the Comparative Examples, including Comparative Example 1, in Applicants' specification show that these presumptions by the Examiner are incorrect.

It is respectfully submitted that the additional teachings of the further secondary references applied by the Examiner would not have rectified the deficiencies of the combined teachings of Fujii and of Kikkawa, et al., such that the presently claimed invention as a whole would have been obvious to one of ordinary skill in the art.

Takashi discloses an adhesive film of which the weight loss after two minutes of heating at 250°C is 100 μf or lower per mm^3 of the film, such adhesive film being obtained by mixing a thermoplastic resin, a thermosetting resin having a molecular weight of 400-1,500, and, if necessary, a filler, in an organic solvent, forming a layer

from the resultant mixture on a substrate, and heating and drying the layer, with removal of the substrate. This patent document goes on to disclose that a polyimide resin is suitable as the thermoplastic resin; and an epoxy resin is suitable as in the thermosetting resin.

Hotta, et al. discloses a metal foil material which is adhered on the surface of a semiconductor device having a semiconductor element encapsulated with a resin. This patent discloses that the metal foil material for covering the semiconductor device is one which is, in molding a resin for encapsulating a semiconductor element using a mold, temporarily fixed on a surface of a cavity of the mold, and is adhered on a surface of a semiconductor device by injecting the encapsulating resin into the mold and molding the resin, wherein a contact angle of the face of the metal foil material which is in contact with the encapsulating resin during molding, to water, is 110°C or less. Note column 2, lines 44-58 of this patent. See also the paragraph bridging columns 2 and 3 of this patent, and the paragraph bridging columns 3 and 4 thereof. As applied by the Examiner, note column 5, lines 31-36, disclosing that incorporation of an inorganic filler into the adhesive layer is effective for controlling adhesion force to the mold cavity face. Note also column 5, lines 51-54.

Nakaso, et al. discloses processes for producing multi-layer printed circuit boards, such processes being described most generally in column 2, lines 21-64 of this patent document. As applied by the Examiner, note also column 7, lines 13-17, of this patent document, describing amount of inorganic filler included in the insulating adhesive layer.

Even assuming, arguendo, that the teachings of Takashi or Nakaso, et al., were properly combinable with the teachings of Fujii and of Kikkawa, et al., or the teachings of Nakaso, et al. and of Hotta, et al. were properly combinable with the

teachings of Fujii and of Kikkawa, et al., such combined teachings would have neither disclosed nor would have suggested the presently claimed subject matter, including wherein the acid dianhydride used in forming the specified polyimide resin constituting at least 50% of the polyimide resin of the adhesive film is an acid dianhydride purified by recrystallization with acetic anhydride, or properties of the polyimide resin and of the adhesive layer as in claim 33, or amount of polyimide resin and epoxy resin as in claim 33 and advantages achieved due thereto; and/or other features of the present invention as in the present claims being considered on the merits herein, and advantages achieved thereby.

In view of the foregoing comments and amendments, and in view of the concurrently filed RCE Transmittal, entry of the present amendments, and reconsideration and allowance of all claims presently being considered on the merits in the above-identified application, are respectfully requested.

To the extent necessary, Applicants hereby petition for an extension of time under 37 CFR 1.136. Kindly charge any shortage of fees due in connection with the filing of this paper, including any extension of time fees, to the Deposit Account of Antonelli, Terry, Stout & Kraus, LLP, Account No. 01-2135 (case 1204.45684X00), and please credit any overpayments to such Deposit Account.

Respectfully submitted,

ANTONELLI, TERRY, STOUT & KRAUS, LLP

By **/William I. Solomon/**
William I. Solomon
Registration No. 28,565

WIS/ksh
1300 17th Street N., Suite 1800
Arlington, Virginia 22209
Tel: 703-312-6600
Fax: 703-312-6666